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Green Turning Brown – Domain Engineering for Social and Health Services in Finland

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Abstract

Being able to design information systems to an untouched domain, without the burden of existing information systems, especially legacy systems, is often seen as a dream of most information system professionals. Uncharted domains are anyway scarce, and often such greenfield projects turn into brownfield projects, also to projects where existing structures severely constrain the development of new systems. In this article we discuss the concepts of greenfield and brownfield domain engineering and software development, and reflect their possible messages to the re-engineering of the Finnish health- and social care ecosystem currently under way. In our fieldwork we could identify a lot of need and wish for greenfield domain engineering in the Finnish health and social services delivery. As well we found a lot of brownfield elements inhibiting change. Our proposal for the future is a ecosystem approach, where new and established elements could live together in a self-governed balance.

Keywords:

Knowledge Management; Information Systems; Decision Making

Introduction

Health and social care are under restructuring in many countries [1], including well-known programs like Obamacare in the US [2] and reform of National Health Service in UK [3] and Sweden [4]. In Finland, the renewal of health and social services (the Finnish SOTE-reform) is currently under way, and it will demand a lot of new governance structures, processes and supporting ICT infrastructure to become a reality, the whole health and social care ecosystem will deeply reinvent itself in Finland. This puts heavy pressures on many domains, including, and not to the least, information systems in the industry. Whereas all would like to see this new ecosystem as a greenfield design, also a design without restrictions from the past, in reality we talk of a brownfield design: old structures must be taken into account, and they often inhibit the implementation of the best available solutions. Greenfield and brownfield terminology is eagerly used in land usage planning [5; 6], but the metaphors of greenfield and brownfield have also found their way to the field of organizational context [7; 8] and information systems [9].

In this article, we review based on academic literature what brownfield and greenfield development means in organizational and industry context, and what it specifically means in the design of information systems. We look for insights that could be used when redesigning information systems in health and social care domain.

Total rework of a large entity can be called domain engineering. Domain engineering is often seen as focusing on software. Domain engineering is relevant to the work required to establish a set of software artifacts that can be reused by the software engineer. The purpose of domain engineering is to identify, model, construct, catalog and disseminate a set of software artifacts that can be applied to existing and future software in a particular application domain [10]. There is anyway evidence that domain engineering is more than just software work: Domain engineering aims to support systematic reuse, focusing on modeling common knowledge in a problem domain [11].

The major alternatives for domain engineering are greenfield and brownfield engineering.

Most of the system and software requirements literature assume development of system from scratch i.e. Green Field Systems [12]. New product development or greenfield process (which does not include constraints for development work like brownfield process) has higher risks. Markets usually have dominant designs, which affect the customer behaviour. When a new product has been developed, there is a risk that the customers do not accept it. Investments to infrastructure of the organization and existing resources have an effect on the selection of whether to develop current products to higher level or to develop completely new products [13].

Lehtonen et al. [13] define that the brownfield (process) stands for the reusing of available assets and it includes notions that there are limitations to designing and solutions because of existing structures. Old product solutions, product structures or customer requirements limit designing of new products. Because of this, the brownfield process is not the preferred solution from the designer point of view. Most organizations in this era have existing large-scale or medium-scale operational systems. With the evolvement of new business requirements arise for change in existing systems to meet evolving business demands and needs. In general, the challenges faced by industries are mainly the capture of requirements for changes and re-engineering in operational systems. Unfortunately, there are very limited approaches defined for re-engineering and changes in existing Brownfield operational systems because most of the system & software requirements in the literature assume the development of system from scratch i.e. Green Field Systems [12].

Infrastucture building is a key task in domain engineering: a domain engineering process should encompasses at least three main activities: domain analysis, infrastructure specification and infrastructure implementation [14].

A common scenario of brownfield system development can be a major upgrade in current operational system in terms of the following requirements [12]:

- Incorporation of new business rules in existing system
- Adding up new feature in existing system
- Up-gradation of existing feature
- Adoption of new technology
- Legalization/Certification of product or specific feature

Today and increasingly in the future, most large software-intensive system (SIS) developments will be constrained by the need to provide continuity of service while migrating their services away from poorly structured and documented legacy software applications. Yet most SIS process models contain underlying assumptions that an application project starts from scratch in an unconstrained Greenfield approach [15]. We feel that this is a more than core description of health and social care projects in most countries – including Finland.

A health and social care system reform has been on the agenda of several Finnish governments. Prime Minister Sipilä´s current government has a plan to put the new health and social care system into operation by 2019. One of the main targets of the ongoing healthcare system reform is to reorganize service providers into larger units called health and social care provider regions. The aim is a full horizontal and vertical integration of health and social care and the primary and secondary levels of services. [16]

New key actors in the new ecosystem will be regions, that will order the health and social care services from the markets, where public, private and third sector service providers compete in equal terms as much as possible. These new regions are yet inexistent, and so are their information systems. They need a totally new ICT infrastructure that is related to and built on the currently available one, but especially systems to manage contracts with service providers, and systems to foresee and plan for service demands, so that they can purchase the right amount and quality of services from the markets. Similar systems are rather unseen in the Finnish context at least; here we are not speaking of ordinary procurement systems [17]. One of the domains where public authorities have most experience of purchasing services might be logistics [18; 19].

Messages from Brown/Greenfield development to health- and social care work

The problem area of Brownfield system development seems to be rather sparsely understood in health and social care information systems field. Much more understanding needs to be gained on how existing structures inhibit the implementation of best new practices. In healthcare, especially the ponderous patient records systems are a core element, to which all new systems must adjust. As well different other systems, such as different coding systems and terminologies inhibit change. On top of everything else, the industry is heavily regulated.

As said, domain engineering is about modelling common knowledge in a domain. Knowledge in the area of medicine especially is extremely extensive, and there is very little room for greenfield engineering or modelling. Yet new ecosystem functions might necessitate a fresh view on knowledge too.

As a reprieve to the problems, IS projects meet with brownfield elements Boehm [15] proposes incremental commitment building. All decisions concerning the new systems are not done at once, and they are not done by just one party. In order to rapidly and successfully adapt to the increasing rates of change, projects need to be able to concurrently, rather than sequentially, assess and manage (1) opportunities and risks; (2) requirements, solutions, plans, and business cases; and (3) hardware, software and human factors [15]. This kind of approach is clearly needed and to a great extend also visible in the Finnish renewal of health and social care.

Brownfield development means that there are established structures, experts and solid knowledge of the domain area already available. Careful listening to experts and taking their ideas into attention and production is a key success factor for brownfield projects. It is important to remember that customers and ordinary staff members are often the best experts in details, even when they are not always able to structure the total picture. The chance of success for Brownfield domain engineering is greatly enhanced if the people working together are effective communicators, like working in teams, are humble, and enjoy learning from others. All of these are important to help create a "no blame" culture, where people aren't afraid to help one another and do what is right for the project [9].

Infrastructure development is a key action in domain engineering. Again, infrastructure in health and social care might in many cases not be the most sophisticated one, but it is usually deeply rooted and difficult to change. Different standards of healthcare message exchange are at the core of infrastructure development in health and social services [20].

Table 1 summarizes our main findings from the literature on brown/greenfield engineering.

Table 1- Main findings from the literature on brown/greenfield engineering

• Greenfield domain engineering is always more risky than brownfield domain engineering • Infrastructure planning (architecture) and implementation are at the core of domain engineering • Contuinity of service is a major goal • Re-use of current resources and assets is a goal of brownfield domain engineering • Listen to experts of the old system • In IS, greenfield engineering aims migrating services away from poorly structured and documented legacy software applications • Incremental commitment building is important in brownfield domain engineering

Methods

Our fieldwork took four months in December 2016 - March 2017 in Southwest Finland. During that time we held 12 expert interviews with Finnish experts in social and healthcare information systems, and one workshop. The theoretical background of green or brownfield domain engineering was not present in the empirical discussions. Our study approach was explorative [21].

Results

In our fieldwork we could identify a lot of pressures and change in agents to the current situation. Genuine interest to design the whole information governance in Finnish health- and social care clearly exists. The main identified factors are summarized in Table 1.

The most clear brownfield element in Finnish health and social care domain of health and social care information governance is the established portfolio of many clinical healthcare information systems. While the amount of different system brands can be counted in thousands, a few main systems – especially patient record systems – account for the main part of current system portfolio. The new and central Finnish main database for health and social care customer information Kanta is on the edge – it can be interpreted as a new building block in an old brownfield landscape.

The current situation in health and social care IS can be described in Finland as waiting. A lot of planning work goes on, but real investments into new systems are few, because of the unclear situation of the upcoming new health and social care governance. It is still widely unclear, what kind of organizations will operate in the new domain, and with which kind of processes and business models, and which kind of incentives are given to different players by government and market forces.

In Finland, there is already a lot of hefty discussion on the future of the fixed property, which will be most likey deserted in the new market environment – especially facilities in rural areas are in danger. Less discussion has been on the same possible fate of heavy investments in current information systems and infrastructure.

Finally, making Greenfield domain engineering is made difficult because of very traditional reasons: lack of finance, lack of vision and direction, and lack of market or other new alternatives that would really look like superior ones as compared to current status.

Table 2 - Main freezers and change agents for information governance in Finnish health- and social care renewal

Main freezers – brownfield elements
• Established patient record systems with high market share • Unclear governance • Unclear processes • Unclear incentive systems and business models • Heavy investments in current system portfolio and infrastructure • Lack of finance • Lack of vision and direction • Lack of superior market offerings
Main change agents – greenfield elements
• Ambitious political goals • Ambitious architecture plans • New regions as actors • Need for decision support • Need for secondary data use • New patient record initiatives • Artificial intelligence, IBM and Watson

Political agenda setting in Finnish health and social care field has been ambitious. However the situation that there would be a lot of fresh resources and areas to untap, which is a key idea in greenfield domain engineering, is missing.

There also seems to be going on some rich and ambitious work on new IS architectures for the health and social care domain. Unfortunately, however, the work seems to form an archipelago; the bridges joining the work items are few and far.

The new regions should act as main change agents. Their capacity and capability to do so is still under speculation, as they are not established yet. The goal is to have strong and wisely led regions as a major change agents for Finnish health and social care domain and its information systems.

There seems to be a strong consensus that especially decision making in the new health and social care domain needs strengthening. Decision makers at all levels should be fed with relevant and fresh information. The same holds true for secondary use of information in research and development domains.

We can also see some new initiatives in the main system portfolio. The nation-wide Kanta-service was already mentioned. In addition, some regions plan for ambitious fresh patient records systems and related functionalities. IBM seems to enter the field strongly with its artificial intelligence Watson concepts, that it seems to utilize as a Trojan Horse to more strongly access the Finnish health and social care IS market.

Discussion

A promising approach for governance and management of the complexity, wide scope and brown/greenfield development of the social and healthcare system is the ecosystem approach. An eHealth ecosystem is composed of healthcare organizations, both public and private, service provider professionals, customers, citizens and patients, industrial companies providing their products and services, and technology-mediated communication and infrastructures that in collaboration provide add-on value for both service consumers and other service providers. Infrastructures and networks are needed both for knowledge sharing and management, and for exchanging and communicating information and data. In an ecosystem, services and products are developed and delivered to fulfill the customers' needs, or regulation-stated needs, and the role of marketing and commercialization is minor [22]. Customers are both health professionals and patients, citizens, and service providers are healthcare organizations and various suppliers and industrial companies to offer systems and services to be used by healthcare organizations and patients. This approach supports very well the regional model of the Finnish social and healthcare reform. Good examples of ecosystem applications and services are electronic health records, personal health records, patient portals and health information systems including health knowledge management and e-learning for healthcare professionals. Further, these systems include clinical decision support systems and remote patient monitoring and management applications to be used at home and on-move by patients and citizens. Wellnes and fitness applications should also be mentioned.

An eHealth ecosystem is very dynamic system that incorporates a varying number of stakeholders. Ecosystem requires enabling information, communication, and empowerment mechanisms, which make it possible for information and expertise to be accessed quickly and

accurately to inform and guide the ecosystem activities and performance. An eHealth ecosystem is very specific in the sense that political decision making has strong effects on how the healthcare services are organized and funded, and also, there is strong legal and normative regulation on how the services can be delivered, accessed, disclosed, charged and funded [23]. Typical for an eHealth ecosystem today is that the services, e.g. electronic health records, need to be delivered online, across distinct organizational, regional or even national borders. This requires that an ecosystem is composed of interconnected stakeholders, each one with a mission to improve the quality of care. In this situation, in order to ensure the patient safety and quality care, the stakeholders build new relationships, often outside the healthcare organization, e.g. develop new types of public-private partnerships [24].

The ecosystem approach on eHealth systems and applications, especially in this new nation-wide social and healthcare reform context, helps healthcare organizations and e-health stakeholders to create business models based on collaborative service production and thus improve collaboration and communication between the stakeholders. The actors, partners of the ecosystem need to share the common objectives of the system and benefit from collaboration, create shared value, and when they have adequate tools and means for communication, collaboration will be active and support the ecosystem sustainability.

eHealth ecosystem can provide many potential benefits for the healthcare professionals and organizations and patients and citizens and for industrial suppliers. However, creating sustainable eHealth ecosystems requires that all stakeholders' opinions and needs are taken into account for ecosystem success and sustainability. Sustainability is important because the benefits often can be achieved only over a period of time. This kind of approach is very relevant, essential, and necessary for the successful governance and management of our planned social and healthcare reform.

Conclusions

Our explorative journey confirmed that terminology and thinking on greenfield and brownfield domain engineering fits well even to the social and healthcare domain information systems development. This to a great amount in health and social care, IS development untapped theoretical construction, and stream of literature and research offers new avenues and insights to research in health and social care IS.

In reality healthcare is plagued with brownfield elements that hamper new openings of IS in the domain. Social care is having less past burden, especially in IS governance, but even there old traditions might heavily hamper new development ideas.

A lot of long-term IS planning in the form of architectures is taking place in the Finnish health- and social care domain. We can easily see that the development initiatives are forming an archipelago, with few bridges between the different plans and a lot of overlapping work.

Incremental commitment building is a key to success in brownfield domain engineering projects. Listening to different stakeholders and allowing them to make their real input to the future IS governance arrangements is an enabler of success, but of course not yet a silver bullet. The cost of this approach is most likely a lot of superimposed work, but this is the cost that has to be paid for consensus. Allowing wide groups of stakeholders to co-produce the plans also serves educational and learning purposes.

Our proposal for a fresh approach is more underlining the nature of an ecosystems of the health and social care domain. Rational top-down planning will never harness the realities of the domain – even not in a small country like Finland. Rather we need more focus on the understanding on how the health and social care ecosystem works, and how IS as a sub-ecosystem in the area works.

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